SYNERGISTIC SOLUTIONS TO MEET TARGET REQUIREMENTS FOR THE SBIRS-LOW DEDICATED TARGET MISSIONS (SDT-1 & SDT-2)

Kent E. Eversmeyer and Robert Harper, Teledyne Brown Engineering, Huntsville, Alabama;
Dan Talbert, Sandia National Laboratories, Albuquerque, New Mexico;
Gerald Caruso, Robert Tucker, and Rudolph (Al) Love,
U.S. Army Space and Missile Defense Command, Ballistic Missile Targets - Joint Project Office,
Strategic Targets Product Office, SMDC-TJ-S, Huntsville, Alabama;

ABSTRACT (U)

This paper provides an overview of the targets planned for the SBIRS-Low Dedicated Target missions, SDT-1 and SDT-2. Results from the process of developing a common set of targets to meet the dual test requirements of the SBIRS-Low : Functional Demonstration System (FDS), (SDT-1) and the SBIRS-Low : Low Altitude Demonstration System (LADS), (SDT-2) is presented. Innovative design solutions for a Reentry Vehicle and associated penaid replica is presented in context of meeting SBIRS-Low target performance requirements as well as overcoming some of the major challenges encountered with payload integration and encrypted telemetry requirements. Solutions for meeting target truth data product requirements for the deployment scenarios of the STARS-II with ODES PBV for SDT-1 (for the dual FDS satellites) and SDT-2 (for the single LADS satellite system) are presented. References for additional information on the SDT target systems are also included.

1. INTRODUCTION (U)

(U) The Space-Based Infrared System (SBIRS), Low earth orbit element (SBIRS-Low) Program Office (SPO) of the U.S. Air Force HQ Space and Missile Systems Center (SMC/MTA) in cooperation with the Ballistic Missile Defense Organization (BMDO) and the National Missile Defense - Joint Project Office (NMD-JPO) will conduct two flight test missions, known as the SBIRS-Low Dedicated Target (SDT-1 and SDT-2) flight tests. SDT-1 and SDT-2 are structured around the use of the Strategic Target System, STARS-II (with the Operation and Deployment Experiments Simulator (ODES) Post Boost Vehicle (PBV)) target delivery system, with a Northern azimuth launch from the Kauai Test Facility (KTF) at the Pacific Missile Range Facility (PMRF), Kauai, Hawaii, targeted for the broad ocean area West of the Continental United States (CONUS).

(U) The SDT-1 and SDT-2 flight tests are scheduled to occur approximately two months apart in late 2QFY00 or early 3QFY00. The missions are designed as demonstration tests for both the SBIRS-Low : Functional Demonstration System (FDS) and the SBIRS-Low : Low Altitude Demonstration System (LADS). The SDT-1 flight test is a dedicated FDS mission and the SDT-2 flight test is a dedicated LADS mission, each designed to test NMD functions for each satellite system.

(U) The SBIRS-Low FDS consists of two satellite systems built by TRW/Raytheon, which are scheduled for launch on a Delta-II in October 1999 from Cape Canaveral, Florida. The SBIRS-Low LADS consists of a single satellite system built by Boeing and is scheduled for launch in September 1999 on a Lockheed Martin Launch Vehicle (Athena) from Cape Canaveral, Florida. Each SBIRS-Low demonstration system (FDS and LADS) requires approximately four months of on-orbit check-out prior to conducting this type of strategic target mission flight test.

(U) The U.S. Army Space and Missile Defense Command, Ballistic Missile Targets - Joint Project Office, Strategic Targets Product Office, SMDC-TJ-S, is the executing agent for NMD strategic targets for the Ballistic Missile Defense Organization (BMDO), and as such directs Sandia National Laboratories (SNL) in the development of the targets payload systems required for the SDT flight tests. SMDC-TJ-S is also the management agency for the STARS target launch vehicle system, and SNL is responsible for integration and launch of the STARS system.

(U) This paper provides an unclassified overview of the target payload systems planned to meet the requirements of testing the FDS and LADS systems on SDT-1 and SDT-2, respectively. The "SDT Target Requirements Letter, dated March 1998," produced by the FDS and LADS Teams is the reference for evaluating the target performance evaluation criteria for the SDT target effort. Specifically, the following information describes a path of "common sense" innovations developed to meet the FDS and LADS test target requirements. These innovations include

physical target design methodologies based on deployment platform boundaries and traceable optical signature performance characteristics, and the need for accurate target truth data products to determine the success of the flight test in post-mission evaluations.

2. FLIGHT TEST OBJECTIVES (U)

(U) The top-level SDT-1 and SDT-2 objectives of the FDS and LADS for SBIRS-Low are to acquire, track, discriminate and report ballistic missile events from lift-off through midcourse. SDT-1 and SDT-2 have identical sets of target payload objects to meet their functional test requirements. Each of these target objects are discussed in later sections.

(U) SDT-1 and SDT-2 are very similar in scope and operation to each of the four previous successful STARS launches from KTF (STARS FTU-1, M-1, M-2, and M-3). However, SDT-1 and SDT-2 will follow similar target launch decision protocols to that of the STARS M-3 flight test also known as the Midcourse Space Experiment (MSX) Dedicated Target (MDT-II) flight test, conducted on 31 August 96. This is due to the rigorous booster / target payloads and satellite engagement timing constraints required to meet the test objectives of both the FDS dual satellites during SDT-1 and for the single LADS satellite during SDT-2.

3. TARGET REQUIREMENTS (U)

(U) The fundamental requirements for the SDT-1 and SDT-2 target payloads are for the deployed target objects which have sufficient physical size, thermophysical and surface optical properties to generate a minimum optical signature Signal to Noise Ratio (SNR) in the FDS and LADS wavebands such that each satellite system can collect sufficient measurements to meet their test objectives. The chosen targets are the result of significant winnowing over a several year period to reach an absolute minimum target set to satisfy SBIRS-Low requirements. In addition, each target payload must be deployed with the appropriate ejection velocity to provide the correct object to object resolution profiles with respect to the engagement geometry and timing constraints of the FDS and LADS satellite systems. Furthermore, each target set for SDT-1 and SDT-2 must be identical in order to facilitate the evaluation of mission performance of the FDS and LADS systems.

(U) To address the launch detection and boost phase tracking objectives of the FDS and LADS systems, the three stage STARS-II booster system and the ODES PBV are considered target objects for tracking purposes. As such, the determination of the metric location of the booster is paramount to meeting FDS and LADS objectives. Determining the truth metrics for the STARS-II system will be made from a combination of GPS, IMU and range radar measurements.

(U) Specific target design and requirements traceability information may be obtained from the "SBIRS-Low Dedicated Target (SDT-1 and SDT-2) Target Support Plan" and the "SBIRS-Low Dedicated Target (SDT) Target Design Reference Handbook" through SMDC-TJ-S. The deployed target payloads for the SDT-1 and SDT-2 flight tests are summarized in the following sections.

3.1 DTRV (U)

(U) The DTRV is a medium sized reentry vehicle test object and is the primary target for the SDT-1 and SDT-2 flight tests. There is a requirement for one each of this target type on both SDT-1 and SDT-2. The DTRV is a non-reentering RV surrogate with unclassified physical and mass properties. However, by clever choices of the DTRV's physical, thermophysical and surface optical properties, the DTRV is predicted to yield an optical signature and sufficient SNR to be traceable within the performance space of interest of a medium class reentry vehicle. This provides benefits to the target system processes of fabrication, flight certification testing, and launch integration, simply because the DTRV is an unclassified target object.

(U) The DTRV is a mono-conic, sphere-cone object made of silica phenolic with a black painted exterior. The DTRV will be deployed from the STARS-II Post Boost Vehicle (PBV) at an ejection velocity of 1.5 meters/second and will have spin stabilized dynamics. The DTRV will be instrumented to produce accurate determinations of deployment velocity, spin rate, precession rate, coning half angle, inertial orientation and position. This will be accomplished through the use of a second generation design of the Light Weight Instrumentation System (LWIS-2) developed by SNL for SMDC-TJ-S. The LWIS-2 configuration for the DTRV will also include a capability for GPS.

3.2 DTRLR (U)

(U) The DTRLR is a medium sized, rigid light replica test object and there is a requirement for one each of this target type on both SDT-1 and SDT-2. The purpose of the DTRLR is to provide a tumbled-dynamics surrogate of the DTRV to investigate track continuation on tumbling RV-like objects. The physical, thermophysical and surface optical properties of the DTRLR are predicted to yield an optical signature to be within the signature performance space as a flight test match in SNR to the DTRV.

(U) The DTRLR is a mono-conic, sphere-cone object made of a Kevlar shell with a black painted exterior. The DTRLR will also be instrumented with a configuration of the LWIS-2 to collect the same flight truth data measurements as the DTRV. The DTRLR will be stacked in a "dixie-cup-style" over the DTRV and will be ejected into a tumbled orientation at approximately 1.5 meters/seconds.

3.3 Canisterized Medium Balloons (CMB) (U)

(U) This target is a 0.9 meter diameter spherical shaped balloon which aptly meets the minimum SNR requirement for a midcourse target object suitable for track function evaluations. There will be two each CMBs on SDT-1 and SDT-2. Each CMB will be instrumented with a configuration of the LWIS-2 to collect flight truth data. The CMBs will be made of Polyurethane Coated Nylon (PCN) with a red exterior and a black interior. The CMBs will be deployed from a canister on the payload plate of the STARS-II PBV at an ejection velocity of approximately 2.3 meters/second.

3.4 Canisterized Large Balloon (CLB) (U)

(U) This target is a 2.2 meter diameter spherical shaped balloon which meets the optical signature SNR requirement for a large midcourse target object suitable for MLWIR and LWIR track function evaluation measurements. There will be one each CLB on SDT-1 and SDT-2. Each CLB will be uninstrumented. The CLBs will be made of Aluminized Mylar with an emissive black exterior and interior. The CLBs will be deployed from a canister on the payload plate of the STARS-II PBV at an ejection velocity of approximately 2.3 meters/second.

4. SUMMARY (U)

(U) The SDT-1 and SDT-2 flight tests have been developed to satisfy test needs associated with both the SBIRS-Low FDS and LADS demonstration satellite systems, respectively. A common sense approach has been applied to the process of satisfying the target requirements and mission design constraints for the SDT-1 and SDT-2 flight tests. The ultimate success of the SDT-1 and SDT-2 flight tests will be determined by post mission evaluation of target payload and booster system truth data with respect to the data collected by the FDS and LADS systems on SDT-1 and SDT-2, respectively. Further information on the target system for these flight tests may be obtained from SMDC-TJ-S.